

New Orleans, Hurricane Katrina, and Global Climate Change

The effects of Hurricane Katrina in New Orleans represent an interesting case study of the complexities of global climate change and our built heritage.

Introduction

More than any other weather event, Hurricane Katrina has caused Americans to seriously consider the human role in global climate change. Though it is not possible to link any specific meteorological event with climatological change that takes place over decades or centuries, climate change has become a familiar topic of speculation with friends and colleagues when discussing the weather. Most Americans, regardless of political persuasion, now acknowledge that human activity is accelerating this phenomenon.

In unveiling its 2008 *World Monuments Watch List* of the world's 100 most endangered heritage sites (which includes New Orleans) the World Monuments Fund states that "human activity has become the greatest threat to our cultural heritage." Human activity has been understood in the heritage community as the wear and tear our presence takes in the form of construction, traffic, our wastes, etc. - on our built heritage. But if human activity melts the polar ice caps thus raising the sea level and warms the oceans making hurricanes stronger and more frequent, then the two are linked. But to frame the discussion of Hurricane Katrina and New Orleans only in the context of climate change oversimplifies the story. This discussion must also include why we choose to live where we do and how we try to shape our environment.

Fig. 1 One month after Hurricane Katrina the Tremé Historic District was still deserted. Water marks show that the flooding was approximately 30 cm above the first floor. Though devastated the decayed charm of the neighborhood and its vernacular Caribbean character is still easily discernible.

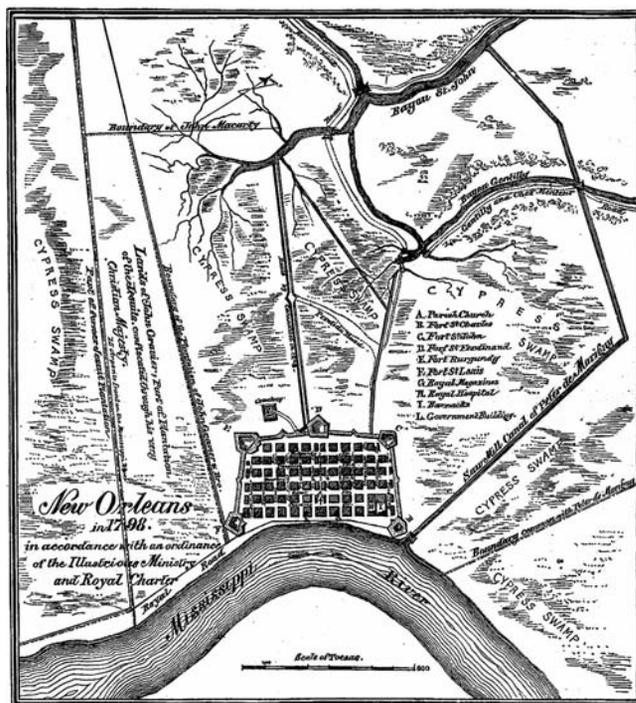


Fig. 2 Map prepared in 1798 shows the Vieux Carré surrounded by cypress swamp. Canals had been provided at this early date to drain water northward into Bayou St. John and ultimately Lake Pontchartrain.

New Orleans and its Fight with the Mississippi

New Orleans, located on America's Gulf Coast, has been described by local scholar Peirce F. Lewis as the "inevitable city on an impossible site." The city is also one of America's greatest outdoor museums and boasts a treasury of architectural styles of local origin as well as magnificent examples imported from other parts of the world and adapted to the subtropical climate, unique geographical conditions, and culture. However New Orleans' charming qualities are not defined by specific building examples but by their collection into evocative streetscapes and neighborhoods as shown in Figure 1.

For Jean Baptiste Le Moyne de Bienville, the area between Lake Pontchartrain and the bend in the Mississippi River seemed ideal for *Nouvelle-Orléans* in 1718. It was a rare bit of natural high ground along the flood-prone banks of the lower Mississippi. This location was picked because the River did not have a mouth into the ocean but simply disappeared into a great swamp. Ships heading down river would unload their goods in New Orleans to be trans-shipped across Lake Pontchartrain to the sea.

The high ground had been formed by natural levees adjacent to the river. These slight ridges are composed of coarse sand and silt (deposited during annual floods) and became the site of the old New Orleans' *Vieux Carré* ("Old Square", better known as the French Quarter) as shown in Figure 2. Finer silts were carried farther northward into the cypress swamps adjacent to Lake Pontchartrain. These northern soils were soft and wet, with alternating layers of sand, silt, soft clays, and organic decaying matter.

It would be difficult to find a location where the natural drainage is worse than New Orleans, owing to a lack of slope in the land and the poor soil. As early as 1725, initial plans emerged to control New Orleans' frequent flooding. The French governor Étienne Périer ordered each property owner along the river bank to construct and maintain a levee two feet (60 cm) high. This plan may have offered protection from water coming into the city but revealed the problem with levees – they prevented rainwater from naturally running off into the Mississippi and would also eventually have to incorporate drainage canals and pumps.

In 1763 the Louisiana Territory was ceded to Spanish control. The territory reverted back to French control by 1801, and was sold to the United States in 1803 bringing an end to the colonial era. New Orleans and the Mississippi Coast cities grew rapidly with influxes of Americans, French and Creoles. New Orleans had a leading role in the slave trade, while at the same time having a prosperous community of francophone *gens de couleur libres* (free persons of color) who had arrived principally from the West Indies. This mix of black and white; slave and free; rich and poor; and English, French and Iberian cultures would give New Orleans its distinct character.

Antebellum Era

The period between 1830 and the American Civil War was the most glamorous and prosperous era for New Orleans. The area hosted wealthy cotton and sugar cane planters, and all related commerce was centered on New Orleans. At this time the practice of erecting structures on masonry piers became prevalent in the region. By raising houses slightly, insect problems were greatly curtailed, chronic dampness was abated, and frequent flooding of the ground after rainstorms was not as great a concern. Flooding was inadequately controlled by levees and a series of drainage canals into which flood waters were pumped and diverted to the northern cypress swamp and Lake Pontchartrain.

Victorian Era

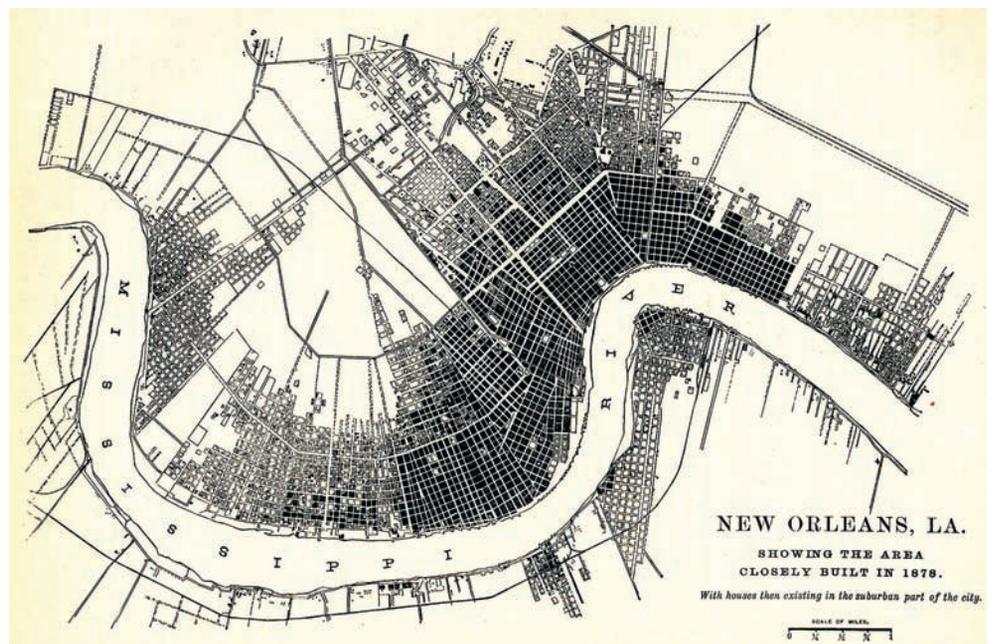
Improvement of the mouth of the Mississippi River for seagoing navigation was first undertaken by Congress in 1837, but the venture proved elusive and costly. Dredging begun by the 1850s had been halted by the American Civil War. It was not until 1867 that dredging operations were resumed. In 1879 a channel to the sea constructed by the renowned construction engineer, James B. Eads, was opened, and direct shipping was open to the sea. This would affect the future pattern of silt deposition along the Mississippi delta.

Though it continued to grow, New Orleans had begun its decline – the advent of the US Railways had removed its trade monopoly between the Northeast and Midwest. Wood-framed construction that supported the Victorian building era following the American Civil War is what makes up most of New Orleans' remaining built heritage. Improvement of the levees along the Mississippi River, and construction of levees along the shores of Lake Pontchartrain began in 1879. However, development of the city was still restricted to the natural levees along the river earning New Orleans the moniker, “the crescent city”, as shown in Figure 3. In what would prove to be a chronic pattern, the city's poorest citizens settled along the fringes of the lowland swamp, in what was referred to as the “back of town.”

The Twentieth Century

In 1882 one of the most disastrous floods ever known devastated the entire delta area. Major floods again occurred in 1912 and 1913. But methods of pumping ground water into canals had greatly improved by the early twentieth century. The bulk of the city's northern boundaries opened for development with the introduction of A. Baldwin Wood's revolutionary centrifugal pump, as shown in Figure 4. Wood's pumps with their mechanisms raised above the water level for ease of maintenance allowed the drainage and con-

Fig. 3 Map prepared in 1878 shows the growth of the “crescent city” along the northern shores of the Mississippi River. The Vieux Carré is north of the tight bend in the river. Though the cities growth now encroaches upon the swamp-lands, these areas were populated by the poor.



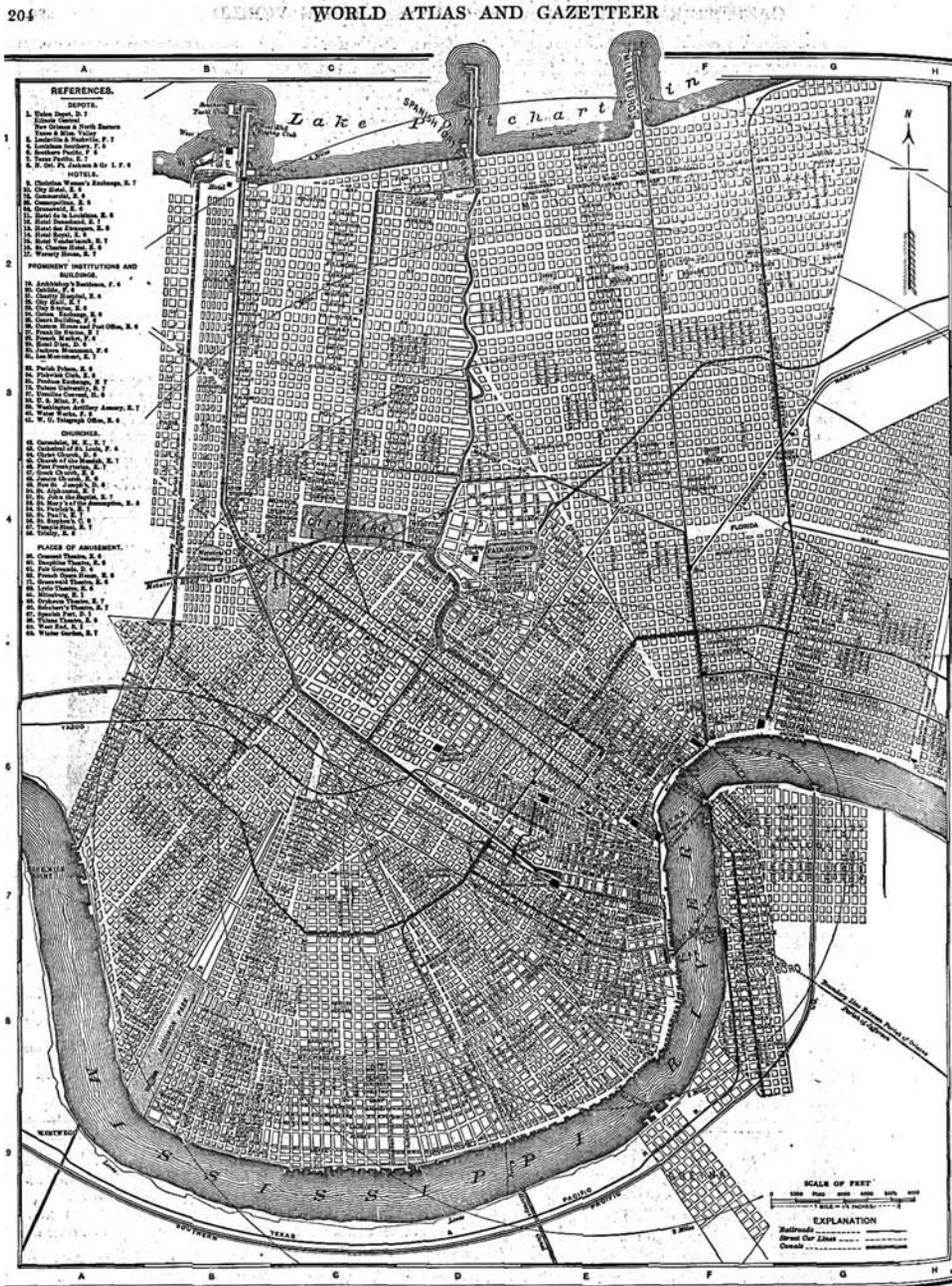


Fig. 4 Map prepared in 1909 shows the growth of New Orleans that now reaches the shores of Lake Pontchartrain. Development in the former swamp areas was realized only after the use of the A Baldwin Wood pumps that proved powerful enough to drain these areas.

sequent development of the city's vast swamps. By 1913, some 17 large pumps generated by eight pumping stations managed 2,810 cubic feet of water per second. Finally, it seemed that New Orleans had won its battle with the river.

Yet the Mississippi River posed another challenge for New Orleans – it had been on the verge of jumping courses in the nineteenth century and again in the twentieth. The second diversion threatened above Baton Rouge along the Atchafalaya River in 1951 and would have left New Orleans aside a swampy, stagnant channel. The Army Corps of Engineers intervened in both instances forcing the river to stay in its present channel and protecting New Orleans' status as an important shipping center. This control of the river would also affect future deposition patterns of the delta.

The control of the Mississippi River and existence of a functioning water management system had led to complacency on the part of local government concerning the habitation of many of its citizens below sea level. The faith in the flood-protection system can

be seen in the evolution of building standards which abandoned residential structures on piers and allowed for slab-on-grade construction. Complacency of the state and federal governments is evidenced by the lack of maintenance of the levee system in the time leading up to Hurricane Katrina.

Present Day

By the post-World War II era it was understood that New Orleans' seeming victory over its chronic flooding problems had come at a cost: the city was sinking. After the flooding of New Orleans caused by Hurricane Betsy in 1965, the US Army Corps of Engineers embarked upon another project to once again strengthen and raise the height of the levees. However the sinking of New Orleans along with its levee system is principally caused by three man-made factors:

- Soil subsidence of the silty Delta soil that was partly natural but was exacerbated by the overburden of building construction and levee systems;
- Pumping the northern swamps dry caused significant subsidence. Such soil is highly susceptible to decreases in volume, when it is dewatered. Newly dried areas of town were soon as much as 10 feet below sea level and continue to sink;
- Construction of levees surrounding New Orleans had prevented the natural deposition of silt from the yearly floods in New Orleans. In effect, areas outside of the levees were becoming higher in comparison as layers of muck and silt collected.

Further consequences of this human activity were seen regionally – loss of coast-line from hurricane storms due to weak depositions, deeper penetration of surges inland from numerous canals to the sea that were dug to facilitate the petrochemical industry, and soil deposition from the pumping of oil from beneath the soil.

The Effects of Hurricane Katrina

Hurricane Katrina was the fourth hurricane of the 2005 Atlantic hurricane season and the third-strongest hurricane on record to strike the United States. It made landfall near New Orleans on 29 August 2005. Its storm surge as high as nine meters devastated the Gulf Coast of Mississippi to the east of New Orleans. However, neither the surge or wind speeds were as great in New Orleans and the damage was principally caused by failure of the levee system. Heritage streetscapes – collections of wood-framed residential structures raised on masonry piers – suffered more from flood than wind damage, as shown in Figure 5.

Three major breaches occurred on the Industrial Canal, one along the 17th Street Canal, and two along the London Avenue Canal. Flooding from the breaches put 80 percent of the city under

water for days and, in the lower Ninth Ward, for weeks. The failure mechanisms investigated by engineers following the flooding included overtopping of levees by the storm surge, consequential undermining of levee foundations or other weakening of the levees by water, and the storm surge pressures exceeding the strength of the levees. Debate over the actual causes – technical, political, and sociological – will undoubtedly continue for many years.

Conclusion

The 1878 map of New Orleans, drawn by T. S. Hardee, shows a city whose populated area is confined to a strip of the east bank of the Mississippi River. This is the area that stayed at or above water during the flooding from Hurricane Katrina. It is a sad reminder that New Orleans is totally dependent on its pumps and levees to survive and much of its land is nothing more than reclaimed swamp.

Models predict that the process of climate change in the form of global warming may continue for decades or centuries even if we stabilize the factors that are causing this problem today. Figuring out how to live with climate change is more urgent than determining how to prevent it. New Orleans' historic districts must now struggle to restore homes while preparing for future challenges posed by rising sea levels and the likelihood of stronger storms.

New Orleans, with its displaced citizens who are primarily poor, is a microcosm of what can be expected in the future from the effects of climate change. Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change, the scientific body that shared the 2007 Nobel Peace Prize with Al Gore, stated "It's the poorest of the poor in the world, and this includes poor people even in prosperous societies, who are going to be the worst-hit."

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Fig. 5 Image inside of a church in the Ninth Ward after the flood had subsided. Wind damage can be seen on the roof and sediment from the flood has "raised" the level of the ground by about 3 cm.